Cosmic Times: 1965

Cosmic Times is a series of six posters with classroom lessons that trace the development of our understanding of the nature of the universe during the past century.

This edition, the fourth of the series, *Cosmic Times*, coincides with the discovery of the cosmic microwave background (CMB), the remnant radiation from very early in the Universe. This new discovery clearly makes the Big Bang the lead theory on the origin of the Universe. The realm of astronomy has grown, with the addition of observations of X-rays from outside the Solar System, and, indeed, outside of the Galaxy. Astronomers have also just gotten their first glimpse of the invisible dark matter.

The language in the 1965 newspaper mimics the style of writing that would have appeared in a real 1965 newspaper. The style is very close to modern-day newspapers, and should not be as difficult for your students as previous papers. However, the concepts may be more difficult than in the previous *Cosmic Times* editions. The layout of the poster also mimics the newspapers of the time. However, we have taken some creative license to make it more readable in a classroom setting.

The *Cosmic Times* website, http://cosmictimes.gsfc.nasa.gov/, provides a complete teacher guide for this poster and the accompanying lessons. There you can also find two newsletter versions of the poster: one of the newsletters contains the same text as the poster, while the other translates the text to a slightly lower reading level. The web site also includes a glossary. We provide here a summary of the articles, a synopsis of the lessons, and two of the lessons.

Summary of the Articles

(for more information, see
http://cosmictimes.gsfc.nasa.gov/1965/guide/teachers_guide.hml)

Murmer of a Bang

A pair of astronomers, Penzias and Wilson, stumbled upon the discovery of the cosmic microwave background. This discovery played a pivotal role in overthrowing the Steady State theory. This article shows that science does not always take the expected route – unexpected discoveries are sometimes the richest discoveries.

Big hiss missed by others

Other scientists had the potential to discover the cosmic microwave background, but were not able to connect the observation and theory.

Supernovae Leave Behind Cosmic X-ray Generators

Not all wavelengths of light are able to penetrate the Earth's atmosphere, so astronomers must use satellites to expand astronomy beyond optical and radio wavebands. This article reinforces the idea of multiwavelength astronomy that was introduced in the 1955 *Cosmic Times* article, "Radio 'Ear' on the Universe Being Built".

Quasars: Express Trains to the Netherworld

Astronomers have discovered objects near the edge of the known Universe that appear to be speeding away from us due to the expansion of the Universe. In addition, we see the shear power these objects must have if we are able to observe them across such great distances.

Galaxies Still Misbehaving

This article illustrates that there is mass in this universe that we cannot account for by studying light alone. In fact, there isn't just a little more matter, but a lot more. This article shows that we can observe phenomena in our universe by their influences on other parts of the universe – in this case, we observe the presence of dark matter through its affect on the motions of galaxies and galaxy clusters.

Summary of 1965 Cosmic Times Lessons

Each of the lessons uses elements of the 5E model of Engage, Explore, Explain, Elaborate, and Evaluate. These lessons may be downloaded from
http://cosmictimes.gsfc.nasa.gov/1965/1965.html

Reading Strategies (grades 7-12)

Students learn several reading strategies that can be used to understand the *Cosmic Times* materials. The students use "Talk to the Text", an independ-ent strategy in which students write their thoughts as they read, and "Recip-rocal Teaching", in which students work in pairs to read and understand a text. This lesson, which is given below, may be used with any of the *Cosmic Times* editions. This lesson is included below.

Cosmic Microwave Background (grades 9-12)

Students explore the cosmic microwave background to understand why it permeates the Universe and why it peaks as microwave radiation. Students will also be able to describe why the Big Bang gives rise to the background radiation. This lesson is included below.

Tornadoes and Galaxies (grades 7-12)

Students study how the Doppler effect helps scientists study both tornadoes and galaxies. Students construct a radar image that depicts a tornado vortex signature and a velocity map of a galaxy indicating the need for dark matter in galaxies. Students compare these to see how the same techniques can be used in different fields of science.

What's the Matter (grades 7-12)

Students explore the density of substances as a model for understanding how astronomers have come to find the existence of dark matter. Students will try to explain why a large foam ball is more massive than expected from measuring similar smaller foam balls.

The Cosmic Microwave Background

Suggested Grade Level(s): 9-12
Estimated class time: 30-45 minutes depending on class ability, assuming they have already read the *Cosmic Times* article

Summary

The purpose of this lesson is to further educate students to the nature of the cosmic microwave background. The lesson is aimed at explaining the surrounding nature of the background and the reason it exists as a microwave radiation.

Objectives

- Students will be able to describe the reason the Big Bang theory yields the creation of a cosmic microwave background.
- Students will be able to describe why the cosmic microwave background is universal and surrounds us.
- Students will be able to compare and contrast changes in the portion of the electromagnetic spectrum in which the radiation resides.

National Science Education Content Standards

NS.9-12.1 SCIENCE AS INQUIRY
NS.9-12.2 PHYSICAL SCIENCE
- Motions and forces
- Interactions of energy and matter

NS.9-12.4 EARTH AND SPACE SCIENCE
- Origin and evolution of the universe

NS.9-12.7 HISTORY AND NATURE OF SCIENCE
- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

Knowledge Prerequisite

Students should be familiar with the electromagnetic spectrum, in particular the fact that all electromagnetic radiation is the same, just composed of different wavelengths and energy levels. They should also be familiar with knowledge that the universe is expanding.

Teacher Background

This lesson involves discussing the early universe and resulting expansion. Throughout the lesson notes are added with extra information to help you aid the students as necessary.
If any students have a latex allergy, then use latex-free balloons in the Exploration section.

Materials

- Balloons (Enough for the class, see precaution in "Teacher Background" section above)
- Markers (Enough for the class)
- 1965 *Cosmic Times*

Procedure

I. Engagement

1. Have the students read 1965 *Cosmic Times* article: "Murmur of a Bang." This can be done either the night before the lesson as homework or during the first part of class.

2. Begin a discussion first by talking about how the radiation was discovered. Then probe the class into a discussion about why the big bang would produce a uniform cosmic background? The main two ideas to make sure that are brought up are
   a. Why is there radiation to begin with?
   b. Why would the radiation surround us and be isotropic? (Smooth, evenly distributed)

3. From here discuss with the students that today we will make a model of the history of the universe. With our model we will explain two ideas. What is responsible for the background radiation and why does it surround us and have the wavelength that it does?

What has happened? Did the group read your note? Perhaps their actions had nothing to do with you at all. What did you actually observe? What might you infer from those observations? How do you find out what was really happening? Believe it or not, this is exactly what science is all about!

II. Exploration

4. Hand each student in the class a balloon and marker. Inform them that these will be the tools used to make our universe.

5. Have them mark their balloon in a manner similar to the image to the right. The picture needs to include a pair of points connected by a line and a wave going around the balloon.

6. Tell the students that this balloon simulates our universe. The wave they drew represents a beam of light and the dots connected by the line represent the distance between to points.

7. Tell them that the big bang theory that is supported by the noted recession distance galaxies indicates that the universe is expanding. Be sure to tell them that this means that the galaxies are not moving away from each other but that the physical distance between them is growing.

8. Have them inflate their balloon. Then ask them the following questions:
   a. What happened to the physical distance between two points on your balloon? *They should indicate that they grew further apart.* Ask them if the two points are actually moving away from each other or did the size of the balloon universe just get larger? *They should indicate that they are now further apart because the balloon got larger.*
   b. Ask them what happened to the wavelength of their light wave? *They should indicate that the wave increased in wavelength and coincidentally decreased in frequency.*

Teacher background: Please point out to your students if they fail to realize that the frequency changes also.

9. Now have them inflate their balloon further. Have the students conclude what happens to the distance between points and the wavelength of a wave that stretches across the universe as the universe grows. They should conclude that the distance gets larger and waves grow in wavelength.

III. Explanation

10. Now talk about what would occur with the big bang. Talk about how scientists believe by winding back the clock we would end up with a hot, small, and compact universe. Tell them that the discovered radiation is consistent with radiation emitted from a thermal source. Make a comparison to the heat given off from their bodies.

11. Continue to describe the early universe. Talk about how the big bang would have created a small early universe filled with electromagnetic radiation. Describe how this early universe is similar to the conditions on the sun where there are no protons or electrons or neutrons. Everything is in a plasma state of motion.

12. Now reference their balloons. Point out in the beginning they have a small universe that is hot. Make a reference to the electromagnetic spectrum of which their body heat is a member. Point out that the early universe was composed of a uniform electromagnetic wave created by the big bang. This wave would be a part of the whole universe.

13. Now explain over time the universe expands. Now reference their balloons again. What happens to the wavelengths of their balloons as the universe grew? *Students should point out that the wavelength grows so the frequency drops and over time the wavelengths would shift to the radio range where the background radiation is found.*

Teacher background: At this point it may be necessary to reference the electromagnetic spectrum. Point out if thermal radiation increased in wavelength, it could end up in the microwave range.

14. Now ask the class, "If the origin of the background is the uniform thermal radiation of the big bang, then would the radiation produced evenly distribute around the small early universe? *They should indicate yes, if not lead them to this idea.*

15. Now have them imagine where the spot the earth would eventually habit would be in this small universe. Does the radiation surround this spot in a uniform manner? *They should indicate yes.*

16. Now refer back to the balloon. If the radiation was everywhere in the early universe, and the universe got bigger (not just moved apart), would the radiation still surround us? They should again indicate yes

Teacher background: Depending on your class composition and ability level, the previous can be conducted two ways: Either a discussion, with note taking occurring individually by the students themselves or in presentation of notes to the students. Just put the major points into bullets and deliver through some sort of visual manner.

17. As a summary of the discussion the students can now write a paragraph summarizing what they have learned. They may share it with a neighbor, group, or the class. Feel free to add your own assessment of the objectives for this lesson.

Reading Strategies

Suggested Grade Level(s): All Grade levels from 7-12
Estimated class time: 45 minutes

Summary

The students will use different strategies from the Reading Apprenticeship philosophy in order to read and understand the concepts presented to them in the *Cosmic Times*. The first one, called "Talking to the Text" (T2T), is an independent strategy in which the students write down their thoughts as they are reading the material. In the second strategy, the students pair up and help each other read and understand the concepts they are reading through reciprocal teaching.

Objectives

The students will use Reading Apprenticeship strategies in order to identify and describe the content of the *Cosmic Times* newspaper articles.

Language Arts Standards

(developed by the National Council of Teachers of English)
- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts

Knowledge Prerequisite

The students should be able to summarize reading material.

Teacher Background

The teacher should have experience working with reading apprenticeship strategies. They can access ideas and concepts from reading apprenticeship through educational resources online, in textbooks, or through materials from the administration. Some of these include:
- Reading For Understanding: A Guide to Improving Reading in Middle and High School Classrooms. (Editors) Ruth Schoenbach, Cynthia Greenleaf, Christine Cziko, Lori Hurwitz; 1999, Jossey- Bass. **Building Academic Literacy: An Anthology for Reading Apprenticeship.** Audrey Fielding (Editor), Ruth Schoenbach (Editor), April 2003, Jossey-Bass.

Materials

Cosmic Times newspapers; sticky notes for talking to the text (if needed)

Procedure

I. Engagement

Ask the students some strategies that they use to help them understand the material that they read for class. Students may be familiar with formal strategies such as SQ3R (Survey, Question, Read, Recite, Review) and suggest those strategies. Students may have simple suggestions such as rereading the material or highlighting important information.

II. Exploration

Explain to the students that they are going to learn some different reading strategies to help them understand the material presented in the *Cosmic Times*.

Ask the students who is the best person to teach them reading. They may respond with the English/Language Arts teacher. Then ask them who is the best person to teach them how to read science, for example, the content in their science book. The answer is the science teacher. Explain to them that because they are in Science Class, the best person to teach them how to read Science is their science teacher because they are experienced in this subject. Once they make this connection, they will understand why sometimes it is easier to read literature in English than to read about scientific concepts such as energy and motion in a physics textbook or dark energy in an astronomy textbook.

III. Explanation

1. Introduce the **Reciprocal Teaching** strategy first. Use the attached explanation for reciprocal teaching to explain to the students. Tell the students that they are to pair up when they read by reciprocal teaching. Students should be paired as partner A and partner B for reading their content and follow the directions as explained.

2. Now introduce the second strategy – **Talking to the Text (TttT)**. This is an individual experience in which the students are invited to write their thoughts on the text as they read. For the *Cosmic Times* they should have copies so that they are free to make comments in the margins and free spaces. They should write down questions, connections, puzzlements, and responses on the text. Please see the attached sheet for an example.

   It is important to provide the students with an opportunity to share their reading experiences with others. Put them in pairs or small groups to share their different markings, debrief the experience, and discuss the text itself.

(These strategies are used all over the world in a variety of ways. If you are not sure how to implement specific parts of each strategy, then test it in your classroom to see what works best for YOUR students. For example, teachers and students often ask during reciprocal teaching if they should have the students read the same paragraph out loud or silently when doing this strategy. The answer to that question depends upon the teacher. If the students can handle reading out loud in the classroom and it works better for them, then go with that. If it is a Friday afternoon and the students are filled with too much energy, have them read the paragraphs silently before summarizing and checking together.)

These strategies can be used for any of the *Cosmic Times* Articles, not just he 1965 Edition of the *Cosmic Times*.

IV. Evalutaion

Check the students' newspaper articles to make sure that they are making comments as they "talk to the text." You can grade the students based on how well they are able to make connections through their comments on their articles.